

DATA MANAGEMENT SYSTEM (DMS) EVOLUTION ANALYSIS

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GOALS

- To Ensure DMS Provisions for Growth & Technology Insertion
 - Planned and graceful evolution
 - Technology transparency
 - System growth margins
- To Ensure DMS Provisions to Support New Requirements
 - Evolving operations & user requirements
 - New Initiative Missions requirements
 - Manned Lunar Base
 - Humans to Mars

NOTES - GOALS

The all encompassing goal for the Data Management System (DMS) Evolution Analysis task is to develop an advocacy for ensuring that growth and technology insertion issues are properly and adequately addressed during DMS requirements specification, design, and development. The most efficient methods of addressing those issues are via planned and graceful evolution, technology transparency, and system growth margins. It is necessary that provisions, such as those previously mentioned, are made to accommodate advanced missions requirements (e.g., Human Space Exploration Programs) in addition to evolving Space Station Freedom operations and user requirements .

OBJECTIVES

- Identify/Define/Understand Evolutionary Impacts on DMS
 - Growth on DMS baseline design
 - Lack of evolutionary planning
- Define/Identify/Recommend DMS Baseline Design Accommodations
 - For SSF evolution
 - For future space activities
- Evaluate/Analyze DMS Evolutionary Baseline Capability

NOTES - OBJECTIVES

In order to achieve the identified goal for the Data Management System (DMS) Evolution Analysis task, several objectives have been established.

It is important to identify and understand the impacts that growth (i.e., in requirements, capabilities, etc.) and the lack of planning for evolution can possibly impose on the DMS baseline design. However, before these impacts can be adequately assessed, the DMS baseline design evolutionary accommodations which have been presented by the Work Package 2 (WP-2) Contractor must be identified and analyzed. To analyze the described provisions in the WP-2 Contractor-provided documentation and to analyze and recommend the evaluation of DMS evolutionary baseline capabilities via prototyping in the DMS Testbed environment can assist in obtaining early details of DMS evolutionary capabilities. If no accommodations can be clearly identified from the WP-2 Contractor's documentation and prototype design, as part of this task, provisions to accommodate evolutionary requirements will be defined and recommended to pertinent personnel and organizations (i.e., DMS System Integration and Development Managers, JSC Project Office, WP-2 Contractor, etc.).

APPROACH

- Identification of DMS Evolutionary Requirements
 - Analysis of baselined documentation
- Identification of DMS Evolutionary Baseline Design Features
 - Hardware scars & software hooks
 - Technology transparency
 - Growth flexibility
 - System design margins
- Recommendations/Comments about DMS Design Approach

NOTES - APPROACH

All Space Station Freedom (SSF) requirements have impacts, either directly or indirectly, upon the Data Management System (DMS) because of the unique integrated relationships of DMS with other distributed systems.

The major thrust of the DMS Evolution Analysis activities is to investigate SSF evolutionary growth requirements together with currently proposed DMS plans, architectures, and capabilities, and to ascertain whether or not these are reconcilable.

Mission evolution requirements, which feed system-level requirements, are numerous and arrive from a variety of sources. Growth at the mission level implies growth/enhanced capability at the system level and imposes incremental resource requirements. Thus, mission resource requirements become part of overall systems requirements. SSF systems requirements are governed by SSP 30000, JSC 31000, and various other documents such as the DMS Architectural Control Document (JSC 30261).

This DMS Evolution Analysis task began with the analysis of NASA baselined requirements documents (SSP 30000 and JSC 31000) to identify/establish DMS evolutionary requirements. These requirements were compiled and are continually being monitored for changes that may result from requirement reviews. Once the requirements had been identified, the evolutionary baseline design features that were proposed by the Work Package 2 (WP-2) Contractor in accordance with the requirements are being analyzed. This includes the identification and assessment of hardware scars, software hooks, technology transparency, and system growth flexibility.

Any comments and/or recommendations that result from the analysis of the design approach will be presented to the WP-2 Contractor for consideration and/or integration into their technology analysis process.

SYSTEM GROWTH REQUIREMENTS

(JSC 31000)

- Processing & Memory Capacity Margins
 - Local memory capacity
 - Growth from minimum 4 Megabytes up to 32 Megabytes
 - Flexible memory configuration
 - Memory increments by "plug-in" installation
- Data System Resources Addition
 - Spare network ports
 - Network segments additions
- Standard, Documented, Non-proprietary Interfaces

WP-2 BASELINE DESIGNS TO MEET JSC 31000 EVOLUTIONARY REQUIREMENTS FOR GROWTH

CORE CAPACITY	GROWTH	DESIGN APPROACH/SCAR
4 MIPS processor w/ 4 MByte memory	Support advanced AI appls. up to 32 MBytes	Technology upgrade to an 8 MIPS processor with direct card replacement; empty slots in ORU for added memory capacity
100 Mbps fiber optic network	Add payload system resources & services to support growth	Comprehensive modular design, resource margins, spare ports, & network expansion provisions
Magnetic disk MSU	DBMS w/ growth capacity	Commercial DBMS which is not size limited; media-independent MSU allows technology insertion (e.g., optical R/W media); spare ports

TECHNOLOGY TRANSPARENCY REQUIREMENTS

(JSC 31000)

- No Major Redesign, Revalidation, or Program Interruption
 - System technology changes
 - Functional capability changes
 - Resource availability changes
- Modular Hardware and Software Designs
- Hooks & Scars
 - Automation & Robotics
 - Autonomous fault identification & recovery
 - Voice activation in Multipurpose Application Console

WP-2 BASELINE DESIGNS TO MEET JSC 31000 EVOLUTIONARY REQUIREMENTS FOR TECHNOLOGY TRANSPARENCY

CORE CAPABILITY	TECHNOLOGY TRANSPARENCY	DESIGN APPROACH/SCAR
Integrated Expert Systems (ES) In AC OMS for Monitor & Control	Evolutionary application of ES to advanced appls.; growth in AI technologies	Spare slots in ORUs & ports on network to add ES engines; seed ES's with hooks for modular expansions; expan- sions to maintenance, inven- tory management
	Complex information inter- faces of telerobotics	ISO/OSI-based communication protocol allows generalized data passing capability with inter- face transparency
	Provision for insertion of new technologies at black box, ORU, subsystem & system level	Standard interfaces at all points comm., protocol, ORU backplanes, local buses, etc.; modular layered H/W & S/W to isolate effects of technology upgrades
	Evolutionary implementation of natural language, con- tinuous speech recognition	Voice recognition incorporated into MPAC; standard inter- faces to spare slots in MPAC to accommodate future advanced voice processors
	Onboard intelligent access to CAD/CAM/CAE databases	Commercially based DBMS promotes space ground compatibility with TMS

APPROACH (contd.)

- Impacts
 - General growth of DMS on baseline design
 - Benefits
 - Costs
- Failure to scar assess
 - Growth capability limitations
 - Major design
 - Technology insertions (upgrades)
- Assessment of Applicable "Lessons Learned"
 - LaRC/Harris "DMS Technology Transparency" Study

NOTES - APPROACH (contd.)

Impact assessment of a system's design is an important part of the overall system analysis process. To date, the Data Management System (DMS) Evolution Analysis task has focused on the impacts in two particular areas - (1) the general growth of DMS on its baseline design, and (2) the failure to scar assess DMS design implementation.

Work Package 2 Contractor's DMS evolutionary design approaches are analyzed in terms of the expected benefits and costs. Benefits are quantified in terms of mission scenario impacts, productivity enhancements, safe designs, system reliability, ease of maintenance, use of common hardware and software, and flexibility to accommodate automation and robotics and other new technologies. Costs include initial hook and scar accommodations and life-cycle costs.

Certainly, to design a system to support a long-lived program, as Space Station, would be extremely costly and unbeneficial to neglect provisions for evolution (i.e., growth and technology insertion). Over a period of time, which could be relatively short with such rapid technological advancements, the cost of supporting obsolete elements/technology could become astronomical; therefore in such a case, replacement technology is more cost-effective. In the case in which new requirements are defined, new functions may be needed; and in turn, the implementation of these new functions may require new technology. If system growth and technology transparency capabilities have not been planned and provided, major redesign may be inevitable.

Lessons learned from previous experiences can be a valuable source. They can be used as guidelines or checklists for design efforts. The Langley Research Center (LaRC)/Harris Corporation study, "DMS Technology Transparency", contains an applicable knowledge base for the Space Station DMS design.

NEAR-TERM PRODUCTS

- **Generation of Reports**
 - **Contents**
 - **Report 1 - DMS evolution hooks & scars**
 - **Report 2 - DMS technology impact**
 - **Anticipated completion date**
 - **April 1990**

NOTES - NEAR-TERM PRODUCTS

Two reports which discuss the to-date findings of the DMS evolution requirements and capabilities are being generated. One report (1) analyzes the requirements that may be imposed on DMS during the 30-year mission of Space Station Freedom (SSF) and (2) the software "hooks" and hardware "scars" that should be in place at the onset of the mission to ensure the ability of DMS to satisfy those long term mission requirements. These requirements include Lunar Base and Mars Mission support, and autonomous operation of SSF.

The other report analyzes trends in technological advances that may be of interest to the SSF Program for upgrades to the DMS equipment during the 30-year mission of SSF. This report suggests baseline configuration that would best ease the insertion of these new technologies into an existing system.

These reported are to be completed by April 1990.

FUTURE PLANS

- **Identify/Understand New Initiative Missions Requirements**
 - **Manned Lunar Base**
 - **Humans to Mars**
- **Study/Investigate DMS Accommodation Capabilities of New Initiative Missions Requirements**

NOTES - FUTURE PLANS

The Human Exploration Initiatives (e.g., Lunar/Mars Missions) with their anticipated new architectures, systems concepts, and technologies, and innovative uses of existing technologies will most assuredly impose demands on Space Station Freedom (SSF) resources.

By reviewing presentation materials and documentation, the mission requirements that have potential impact on the SSF Data Management System (DMS) design can be identified and understood.

In order to avoid redesign or major systems disruption, it is necessary that the DMS design is adequately scarred to accommodate such mission requirements as referenced and more that will probably be later defined. Work Package 2 (WP-2) Contractor's DMS evolutionary plan has been developed to consider a wide range of potential growth requirements from various sources; however, as part of this DMS Evolution Analysis task, Human Exploration Initiatives requirements will be specifically compared with DMS capabilities obtainable with WP-2 currently proposed DMS architecture and design parameters.

SSF DMS DELTA BUILDUP FOR LUNAR / MARS INITIATIVES

First Node Event 1999 (delta to AC)	Lunar Mission Node 1 2000 (delta to 1st node event)	Lunar Mission Node 2 2003 (delta to LMN1)	Lunar & Mars Mission Node 2015 (delta to LMN2)
+Local bus & high rate links in LTV area (Support data comm for vehicle processing) +2 workstations (Control LTV processing activities)		+Local bus & high rate links in CSF area (Support data comm for CSF activities) +1 workstation (Control CSF processing activities)	+Local bus & high rate links in MTV area (Support data comm for MTV processing)

SSF DMS TOTAL SYSTEM REQUIREMENTS

FOR

LUNAR / MARS INITIATIVES

First Node Event 1999 (1st LTV mission) Assembly complete capability Local bus and high rate links in LTV processing area 10 fixed workstations	Lunar Mission Node 1 2000 (expendable LTVs) Assembly complete capability Local bus and high rate links in LTV processing area 10 fixed workstations	Lunar Mission Node 2 2003 (reusable LTVs) Assembly complete capability Local bus and high rate links in LTV & CSF processing area 11 fixed workstations	Lunar & Mars Mission Node 2015 Assembly complete capability Local bus and high rate links in LTV, MTV, & CSF processing area 11 fixed workstations
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FUTURE PLANS (contd.)

- System Analysis Updates
 - Influential Inputs
 - Changing/Evolving requirements
 - Design changes
 - Comments/Recommendations/Reports
- Investigation of System Representational Methodology
 - Purpose
 - To reconcile mission & system requirements with proposed DMS capabilities
 - Trade study for computer-aided system
- Inputs to DMS Advanced Technologies Evaluation/Study
 - Future capability needs
 - Enabling/Enhancing technology needs
 - Automation

NOTES - FUTURE PLANS (contd.)

At this phase in the Space Station Freedom (SSF) Program, requirements are still evolving, and so is the architecture. Consequently, the system analysis process which has been described for this Data Management System (DMS) Evolution Analysis task is not a "finite" process, instead it is very much iterative. As information is gathered and compiled, interim reports, comments, and recommendations will result.

The SSF DMS requirements and architectural design information currently is in a state of flux, owing to impending software and the overall DMS preliminary design reviews (PDR). Some of it is in document form, and some must be obtained through a series of dialogues with concerned individuals. Therefore, in order to reconcile requirements with the Work Package 2 proposed architectural and design capabilities, a special type of representational methodology will be investigated. This methodology could also assist in simulation processes, based upon various types of models and other system descriptions. In order to accommodate simulations, if so desired, trade studies will be performed for a computer-aided system for handling system representations, with requirement information as input, and with parameters, structures, and data suitable to drive simulators as output.

The system evolution analysis process is helping to reveal future capability needs which can possibly be fulfilled with the use of advanced technologies. It will prove useful to be able to evaluate the capabilities of candidate advanced technologies along with their upward compatibility with the already proven and presently used technologies. Inputs from this DMS Evolution Analysis task into the DMS Advanced Technologies Evaluation/Study task will help to ensure technology readiness for anticipated future capabilities.